V.

EMISSIONS

California's extreme air quality problems require unique strategies for meeting federal and State ambient air quality standards. In this chapter, we provide an overview of these air quality problems and the need for significant emission reductions from all sources of air pollution. We also describe the need for the regulation of architectural coatings and provide a detailed summary of the emissions from the categories proposed for regulation.

A. AMBIENT AIR QUALITY AND THE NEED FOR EMISSIONS REDUCTIONS

Volatile Organic Compound (VOC) emissions contribute to the formation of both ozone and PM_{10} (particulate matter less than 10 microns equivalent aerodynamic diameter). Ozone formation in the lower atmosphere results from a series of chemical reactions between VOCs and nitrogen oxides in the presence of sunlight. PM_{10} is the result of both direct and indirect emissions. Direct sources of PM_{10} include emissions from fuel combustion and wind erosion of soil. Indirect PM_{10} emissions result from the chemical reaction of VOCs, nitrogen oxides, sulfur oxides and other chemicals in the atmosphere.

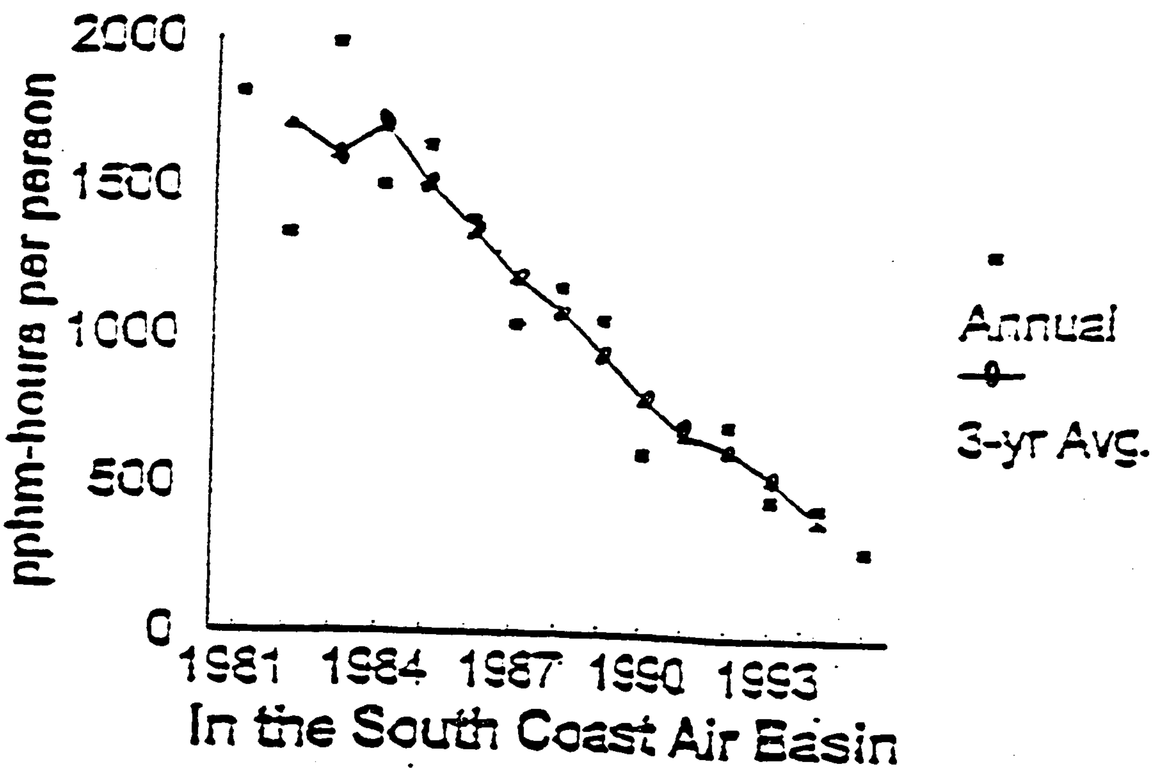
Ozone

VOCs and nitrogen oxides (NO_x) react in the presence of sunlight to form ozone. The rate of ozone generation is related closely to the rate of VOC production (in the form of reactive organic gases, or ROG) as well as the availability of NO_x in the atmosphere (U.S. EPA, 1996; Seinfeld and Pandis, 1998). At low ambient concentrations, ozone is a colorless, odorless gas, and the chief component of urban smog. It is one of the State's more persistent air quality problems. Air quality data have revealed that 75 percent of the nation's exposure to ozone occurs in California (ARB, 1994a). As shown in Figure V-1, the population-weighted average exposure to ozone concentrations above the State ambient air quality standard of nine parts per hundred million in the South Coast Air Basin has been declining. However, despite this decline and nearly 25 years of regulatory efforts, ozone continues to be an important environmental and health concern.

It has been well documented that ozone adversely affects the respiratory functions of humans and animals. Human health studies show that short-term exposure to even very low levels of ozone injures the lung (ARB, 1997; U.S. EPA, 1996). Ozone is a strong irritant that can cause constriction of the airways, forcing the respiratory system to work harder in order to provide oxygen to the body. Besides shortness of breath, it can aggravate or worsen existing respiratory diseases such as emphysema, bronchitis, and asthma (U.S. EPA, 1996).

Chronic exposure to ozone may cause permanent damage in deep portions of the lung. In some animal studies, permanent structural changes due to long-term ozone exposure were noted. These changes remained even after periods of exposure to clean air (U.S. EPA, 1996). The ARB is currently conducting a study to determine the effects of ozone on lung development. The is currently conducting a study to determine the effects of ozone on lung development. The "Epidemiologic Investigation to Identify Chronic Health Effects of Ambient Air Pollutants in Southern California" is a long-term study which is documenting the lung development of children in 12 cities in California. The air quality in these 12 communities varies from good to moderate and poor, so any trends in lung development may be determined. Preliminary results of this on-going study do indicate that chronic ozone exposure slows lung development, although no conclusions specific to ozone have been drawn.

Figure V-1
Population-Weighted Exposure to Ozone Concentrations Above the State Ambient Air Quality Standard



Not only does ozone adversely affect human and animal health, but it also affects vegetation throughout most of California resulting in reduced yield and quality in agricultural ozone levels are often highest in the urban centers in Southern California, the San Joaquin Valley, and Sacramento Valley, which are adjacent to the principal production areas in California's multibillion-dollar agricultural industry. ARB studies indicate that ozone pollution damage to crops is estimated to cost agriculture over 300 million dollars annually (ARB, 1987). Similarly, the U.S. EPA estimates national agricultural losses to exceed 1 billion dollars annually (U.S. EPA, 1996).

PM_{10}

Airborne particulate matter (PM_{10}) is a solid or liquid substance with less than (<) 10 microns determined as the equivalent aerodynamic diameter. PM_{10} can be directly emitted into the atmosphere as the result of anthropogenic actions such as fuel combustion or natural causes such as wind erosion. Indirect PM_{10} is formed via a complex reaction involving a gas-to-particulate matter conversion process in which VOCs can participate (Seinfeld and Pandis, 1998). The focus of this discussion will be on the indirect aerosol formation of $PM_{10.}$

PM_{10} is composed of up to 35 percent aerosols which may be the result of atmospheric chemical reactions of sulfate, nitrates, ammonium, trace metals, carbonaceous material (VOCs), and water. The products of the gas-phase reactions may combine to form new particles (either single or two or more vapor phase species) or increase existing particle growth by condensation of VOCs (Seinfeld and Pandis, 1998). Furthermore, although the contribution from VOCs is not known, carbonaceous aerosols generally account for a significant fraction of the fine (<2 micron equivalent aerodynamic diameter) urban particulate matter. In Los Angeles, for example, aerosol carbon alone accounts for about 40 percent of the total fine particulate mass (Seinfeld, 1989).

PM_{10}, and specifically, its smaller fraction, $PM_{2.5}$, are inhaled deep into the lungs, causing significant adverse health effects. The particulate matter irritates the respiratory tract, and may contain toxic as well as carcinogenic compounds (Godish, 1991). Epidemiologic evidence indicates that certain populations are particularly sensitive to PM_{10}, including the elderly, persons suffering from lung or cardiopulmonary disease, infants and children, and asthma sufferers. These populations suffer a range of health effects. Among children, decrements in lung function occur, leading to increased school absences, and asthmatic individuals may suffer from increased respiratory symptoms. Among the elderly and in individuals suffering from cardiopulmonary disease, exacerbations of chronic disease leading to increased hospital admissions are seen (U.S. EPA, 1997). PM_{10} also contributes to reduced visibility.

To protect California's population from the harmful effects of ozone and PM_{10}, federal and State air quality standards for these contaminants have been established. These standards are shown in Table V-1. The State hourly ozone standard is nine parts per hundred million (pphm) and the national hourly ozone standard is 12 pphm. The State PM_{10} standard for a 24-hour period is 50 micrograms per cubic meter (µg/m^3), and the national standard is 150 µg/m^3 over a 24-hour period.

Table V-1 Ambient Air Quality Standards for Ozone and PM_{10}			
Pollutant	**Averaging Time**	**State Standard**	**National Standard**
Ozone	1 hour	9 pphm (180 $\mu g/m^3$)	12 pphm (235 $\mu g/m^3$)
PM_{10}	Annual Geometric Mean 24 hour Annual Arithmetic Mean	30 $\mu g/m^3$ 50 $\mu g/m^3$ -------	-------- 150 $\mu g/m^3$ 50 $\mu g/m^3$

In 1997, the U.S. EPA promulgated a new national eight-hour ozone standard, and new national standards for particulate matter (PM_{10} and $PM_{2.5}$). On May 14, 1999, the U.S. Court of Appeals for the District of Columbia put implementation of the new standards on hold. The Court ruled that the agency had overstepped its constitutional authority in setting the new standards because, among other things, it did not clearly articulate the rationale used in selecting specific levels for the standards. The Court remanded all of the standards to the U.S. EPA for further consideration. During remand, the status of the standards is as follows: (1) the Court vacated the new PM_{10} standard; (2) the Court left the new eight-hour ozone standard in place, but held that the standard "cannot be enforced"; and (3) the Court will decide in the future whether the $PM_{2.5}$ standard should be vacated outright, or remain in place while the case is remanded to the U.S. EPA. The U.S. EPA appealed the court's decision to the full U.S. Court of Appeals; however, a narrowly divided Court let the decision stand. U.S. EPA asked the Supreme Court to review the decision and is awaiting their response.

The court decision has no immediate impact on California's air quality programs, because most of California continues to violate the pre-existing national and State one-hour ozone and PM_{10} standards, and the court decision did not affect the applicability of these standards. The pre-existing national one-hour ozone and PM_{10} standards continue to apply. Also, California's State standards continue to apply. (In general terms, California's one-hour ozone standard is similar in its impact to the new federal eight-hour ozone standard.) Regardless of the ultimate legal fate of the new federal standards, ARB and the districts will need to pursue new emission reduction measures to attain the existing standards.

The vast majority of California's population who live in urban areas breathe unhealthy air for much of the year, as clearly shown in Figure V-2 (ARB, 1998). Lastly, Figures V-3 and V-4 show that unhealthy levels of ozone and PM_{10}, respectively, are not limited to just urban areas, but can be found in nearly every county in California. As shown in these maps, 46 counties and portions of counties are currently designated as nonattainment for the State ozone standard, while 54 counties are designated as nonattainment for the State PM_{10} standard (ARB, 1999). These counties contain over 97 and 99 percent, respectively, of California's population, a clear indication of the extent and magnitude of the ozone and PM_{10} problems in California.

The California Clean Air Act requires districts that have been designated nonattainment for the State ambient air quality standards for ozone, carbon monoxide, sulfur dioxide, or nitrogen dioxide to prepare and submit plans for attaining and maintaining the standards (see Health and Safety Code §40910 *et seq.*). In addition, the federal Clean Air Act requires that districts designated nonattainment for the federal ambient air quality standards prepare State Implementation Plans to demonstrate attainment with the federal standards. In some of these districts, substantial additional emission reductions will be necessary if attainment is to be achieved. In developing their plans, each district determines which measures are necessary to include, as well as the specific details of each included measure.

The plans from various districts underscore the increasing role of pollution from areawide sources, including consumer products and architectural coatings. As emissions from facilities and vehicles are reduced, the widespread areawide sources become a larger part of the inventory, and are included as a more significant area for potential reductions of VOC emissions. It is estimated that without additional architectural coatings regulations, the inventory for architectural coatings emissions will increase due to population growth.

Figure V-2
California Exceedences of
State Ambient Air Quality Standards During 1997

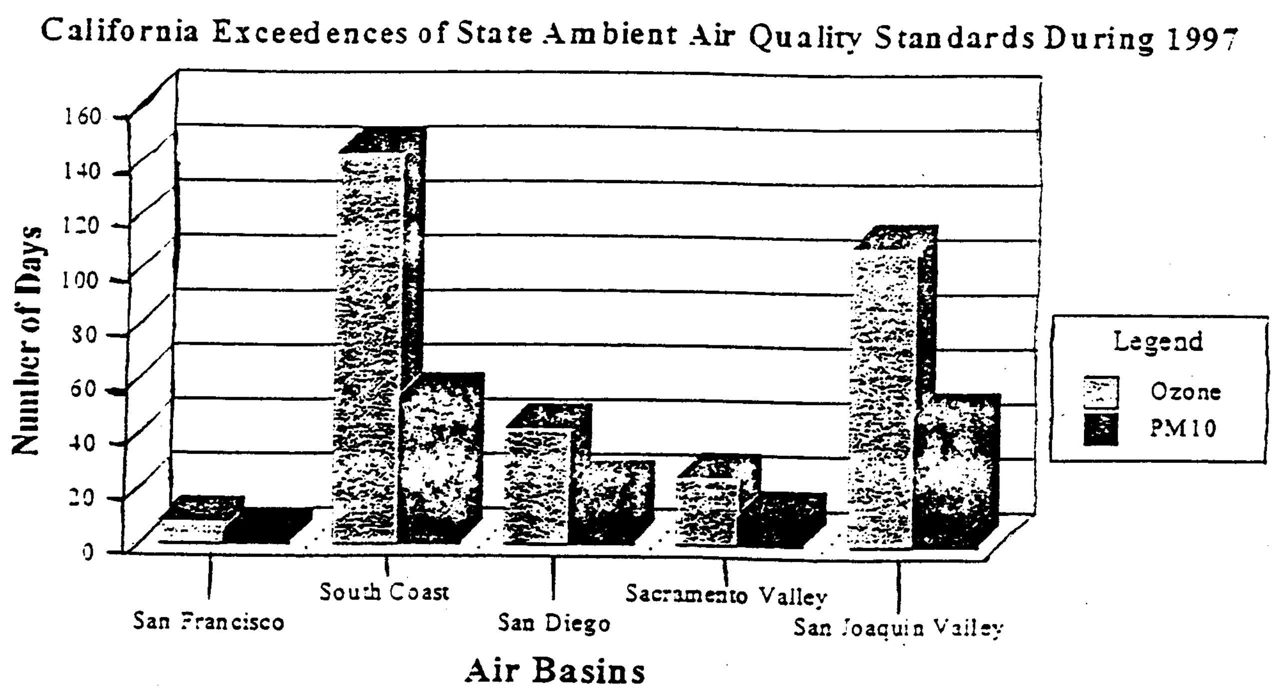
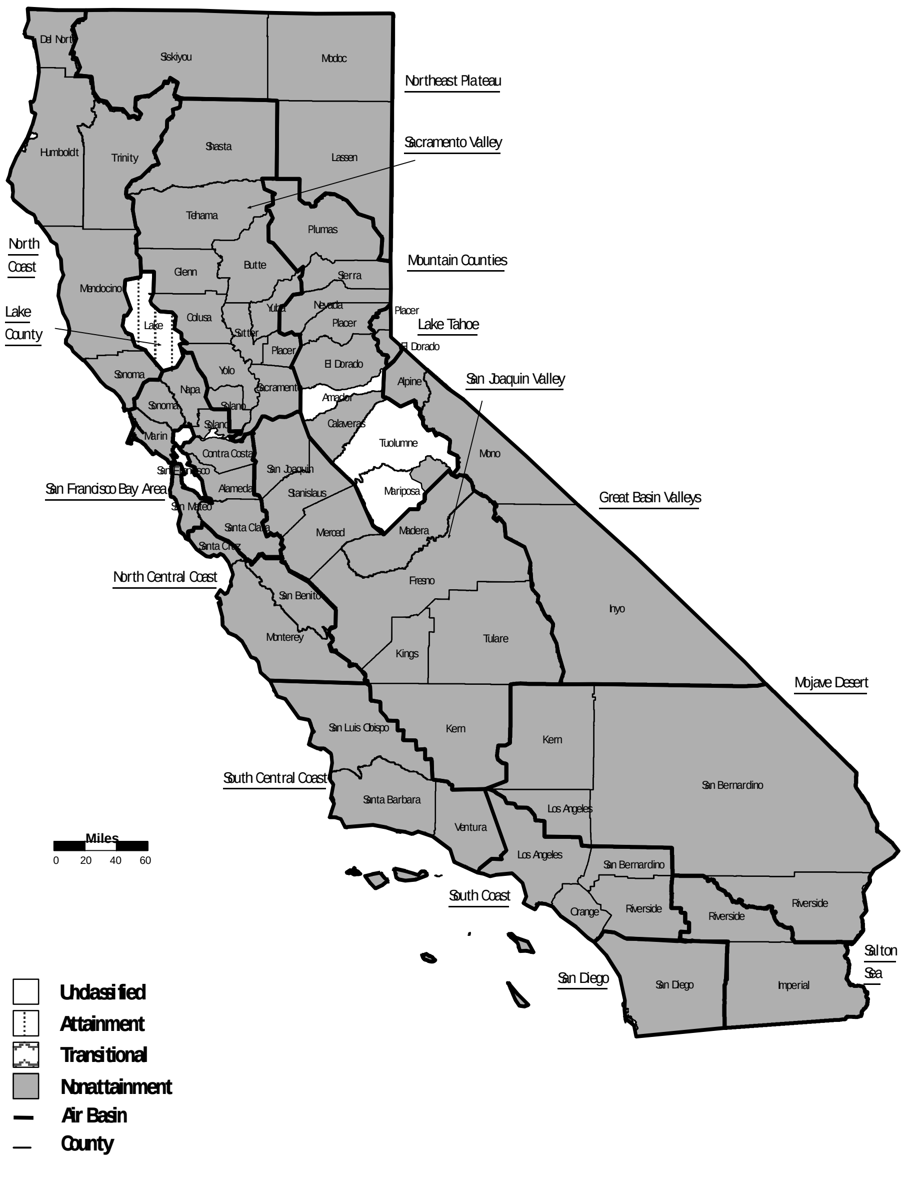


Figure V-3
Area Designations for State Ambient Air Quality Standard for Ozone

Figure V-4
Area Designations for State Ambient Air Quality Standard for PM_{10}



B. WHY REGULATE ARCHITECTURAL COATINGS?

Over the past 25 years, air pollution control agencies in California have been working diligently to improve air quality. Much of the effort was directed to the more traditional sources of air pollution such as mobile sources (e.g., cars, trucks, etc.) and stationary sources (e.g., factories, power plants, etc.). There have been dramatic gains in reducing emissions from these traditional sources. However, to continue to make progress toward meeting the State and federal ambient air quality standards and protecting the public health of California citizens, there is a need for further reductions from other sources of emissions including architectural coatings. Also, as emissions from the traditional sources are further reduced, emissions from all other sources, including architectural coatings, have become more significant. Therefore, the emissions from these sources must be evaluated for possible reductions.

Architectural coatings comprise an important source of emissions in California because they are widely distributed, emit VOCs when used, and contribute to the air pollution problem in California. Although each container of paint may seem to be a small source of emissions, when the total number of users in California is aggregated, the total VOC emissions become significant. As the population in California continues to grow, the VOC emissions from architectural coatings will also grow.

Recognizing the importance of the potential impact of VOC emissions from architectural coatings, the local districts began regulating the VOC content of architectural coatings in 1977. Because each district was free to adopt its own architectural coatings rule, the rules varied by district, raising compliance issues for companies which manufacture and distribute products nationally or statewide. To attempt to resolve these issues, the Air Resources Board amended its existing suggested control measure for architectural coatings in 1989 to act as a model rule for districts. The goal was to bring statewide uniformity to the various architectural coatings rules.

In its attainment demonstration in the 1994 Air Quality Management Plan (AQMP), the South Coast AQMD projected that, if left unchecked, architectural coatings emissions would account for 26 percent of the allowable VOC emissions by the year 2010. The 1994 AQMP thus contains a control measure that would reduce architectural coating emissions by 75 percent, or 62 tons per day, by 2010 (South Coast AQMD, 1996). The South Coast AQMD Rule 1113 amendments of November 8, 1996, will reduce VOC emissions by 18 percent (South Coast AQMD, 1996), while the May 14, 1999, Rule 1113 amendments will achieve a 38 percent emission reduction compared to the current emission inventory, on an annual average basis (South Coast AQMD, 1999). Large VOC reductions are also needed to attain the federal ozone standard in other districts such as Ventura County and San Joaquin Valley APCDs, and the Yolo-Solano AQMD. All of these VOC reductions were committed to in California’s 1994 Ozone SIP.

Achieving significant VOC reductions from architectural coatings is a key element of the California Ozone SIP (ARB, 1994b). The SIP was adopted by the ARB on November 15, 1994, and serves as California’s overall long-term plan for the attainment of the federal ambient air quality standard for ozone by early in the 21st century. Together with significant reductions from stationary industrial facilities, mobile sources (e.g., cars, trains, boats), and other area sources (e.g., consumer products), the architectural coatings reductions in the SIP are an essential part of California's effort to attain the air quality standards for ozone. Through the implementation of the proposed SCM, we will continue to make progress toward meeting California's SIP commitment for ozone attainment.

The 1994 Ozone SIP only addresses commitments to achieve the federal 1-hour air quality standard for ozone. Both the federal 8-hour ozone standard (if promulgated) and the State ozone standard are more stringent than the federal 1-hour standard, and will require even greater emission reductions to achieve attainment.

The applicable State and federal law show that both the U.S. Congress and the California Legislature intended progress toward clean air to be made as quickly as possible. The California Clean Air Act (the Act) specifically declares that it is the intent of the Legislature that the state air quality standards be achieved "...by the earliest practicable date..." (see HSC, sections 40910 and 40913(a); see also the uncodified section 1(b)(2) of the Act (Stats. 1988, Chapter 1568)). A similar intent is expressed in the federal Clean Air Act, which declares that the federal air quality standards are to be achieved "...as expeditiously as practicable..." (see sections 172(a)(2), 181(a), and 188(c) of the federal Clean Air Act).

C. ESTIMATED EMISSIONS FROM ARCHITECTURAL COATINGS

Emissions from architectural coatings are estimated from surveys of architectural coatings sales in California that the ARB has conducted over the past 20 years. The four most recent surveys collected sales and emissions data for coatings sold in California in 1984, 1988, 1990, and 1996.

The 1998 ARB survey, which collected data for coatings sold in 1996, was sent to over 700 companies that potentially sold architectural coatings in California. Unlike previous surveys, this survey asked for information on the speciation of VOCs. We received responses from 340 companies, 152 of which submitted survey data. This compares favorably to the previous three ARB surveys, in which an average of 149 companies responded with data. A workshop was held in March 1999 to receive comments on the draft survey results. The draft speciation data was reviewed by industry in June 1999. The final survey report was published in September 1999 (ARB, 1999).

Table V-2 compares the ARB survey results for architectural coatings sold in 1990 and 1996. This table shows that the estimated annual emissions were reduced from 126 TPD in 1990 to 117 TPD in 1996. These data also show that architectural coatings in California are continuing to shift toward water-based, low-VOC coatings. In 1990, the split between water-based and solvent-based coatings was roughly 75 percent and 25 percent, respectively. The 1996 survey data show closer to an 80 percent/20 percent water-based/solvent-based split, respectively. The per capita use of coatings was relatively constant between 1990 and 1996. These trends seem to indicate that emissions from architectural coatings are declining, assuming that the growth in population and housing does not offset any trend in reductions. Also, because the increase in volume from 1990 to 1996 was roughly equal to what would be predicted based on growth alone (i.e., two percent per year), we did not adjust the inventory to account for incomplete market coverage from the survey process. We believe we captured about 98 percent of the California coatings market with the 1998 ARB survey.

Table V-2
1990/1996 Survey Comparison

	1990	**1996**
Total volume, gallons	77.1 million	87.5 million
Water-based/solvent-based split, %	76/24	82/18
Estimated emissions (TPD), annual average day	126	117
Gallons per capita	2.6	2.7
Emissions per capita (pounds)	3.1	2.6

The ARB and district staff use survey data, coupled with information on the growth of coating use and the level of emissions control from local district rules, to estimate emissions from architectural coatings in the future. The data in Tables V-2 and V-3 are presented in 1996 values, as annual average emissions. The values used in ozone attainment plans are usually presented as average summer emissions, since the peak ozone season in California is typically the summer. The estimated emissions on an average summer day are greater than on an average annual day because more painting is done in May through October than the rest of the year, due to weather conditions. Annual average daily emissions spread out these higher summer emissions evenly throughout the year.

The 1995 ARB emissions inventory estimates the emissions from all stationary sources to be about 1600 tons per day, with architectural coatings contributing about eight percent of the stationary source emissions, or about 130 tons per day. This estimate was based on the 1990 architectural coatings survey data. These estimates have not yet been officially updated based on the 1996 survey data.

Table V-3 shows the estimated emissions from the architectural coatings categories included in the proposed SCM are about 54 tons per day (excluding South Coast AQMD) based on the 1998 ARB survey. The statewide emissions estimate for all the categories surveyed is about 100 tons per day. After estimates from thinning and cleanup emissions are included, the architectural coatings emissions estimate is about 117 tons per day. The table also shows that the emissions from the eleven coating categories, for which emission reductions will be achieved from the proposed SCM, account for almost 80 percent of the total emissions from all of the coating categories in the SCM. These eleven categories are shown in bold in Table V-3.

Table V-3 VOC Emissions By Product Category	
Coating Category	**VOC Emissions (excluding South Coast AQMD) (tons/day)**
Flat[1]	**8.00**
Non-flat - High Gloss - **Medium Gloss** - **Low Gloss**	 2.17 **6.75** **1.73**
Specialty Coatings:	
Antenna Coatings	*
Antifouling Coatings	*
Bituminous Roof Coatings	1.42
Bituminous Roof Primer Coatings	Not surveyed
Bond Breakers	0.02
Clear Wood Coatings - Clear Brushing Lacquers - **Lacquers (incl. Lacquer sanding sealers)** - Sanding Sealers (other than lacquer sanding sealers) - Varnishes	 Not surveyed **2.50** 0.46 1.74
Concrete Curing Compounds	0.24
Dry Fog Coatings	0.26
Faux Finishing Coatings	Not surveyed
Fire-Resistive Coatings	Not surveyed
Fire-Retardant Coatings - Clear - Opaque	 * 0.03
Floor Coatings	0.79
Flow Coatings	*
Form-Release Compounds	0.02
Graphic Arts Coatings (sign paints)	0.03
High-Temperature Coatings	0.05
Industrial Maintenance Coatings	**7.84**
Low Solids Coatings	*
Magnesite Cement Coatings	0.14
Mastic Texture Coatings	0.15
Metallic Pigmented Coatings	0.81
Multi-Color Coatings	**0.04**
Pre-Treatment Wash Primers	0.04
Primers, Sealers, and Undercoaters	**4.59**
Quick-Dry Enamels	**2.24**
Quick-Dry Primers, Sealers, and Undercoaters	**3.27**

Table V-3 (continued) VOC Emissions By Product Category	
Coating Category	**VOC Emissions excluding South Coast AQMD (tons/day)**
Recycled Coatings	Not surveyed
Roof	0.30
Rust Preventative Coatings	0.14
Shellacs - Clear - Opaque	 0.11 0.41
Specialty Primers, Sealers, and Undercoaters	Not surveyed
Stains	**3.89**
Swimming Pool Coatings	0.01
Swimming Pool Repair and Maintenance Coatings	**0.05**
Temperature-Indicator Safety Coatings	Not surveyed
Traffic Marking Coatings	2.02
Waterproofing Sealers[2] - Concrete **- Wood**	 0.46 **1.08**
Wood Preservatives	0.51
Total	**54.3**

1 Bold indicates categories that account for the majority of the emission reductions in the proposed SCM.

2 Emissions based on the South Coast AQMD's estimate that 30 percent of the emissions for waterproofing sealers are contributed by coatings for concrete, and the remaining 70 percent by coatings for wood.

* Emissions are less than 0.01 tons per day.

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